# NASA GEOS Aerosol DA System and $PM_{2.5}$

**K. Emma Knowland**

Morgan State University/GESTAR-II

NASA Global Modeling and Assimilation Office (GMAO)

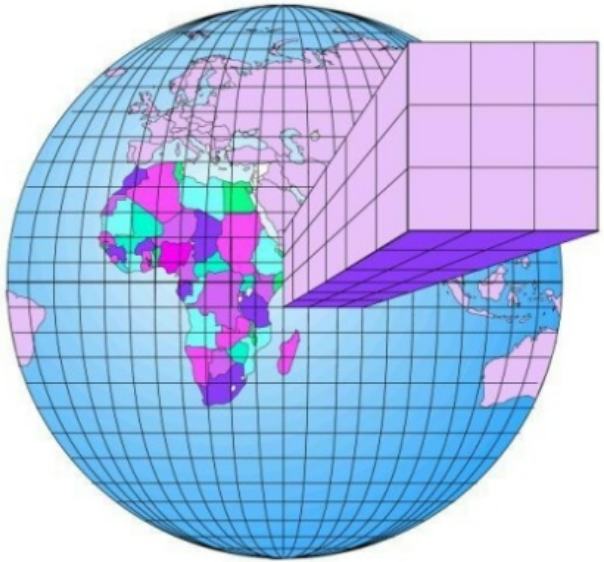
**In collaboration with:**

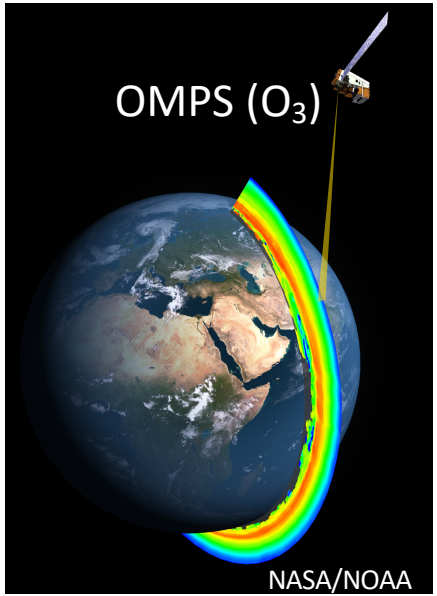
NASA GMAO: Allison Collow, Patricia Castellanos, Virginie Buchard, Arlindo da Silva, Anton Darmenov

Atmospheric Chemistry and Dynamics Lab: Peter Colarco, Mian Chin

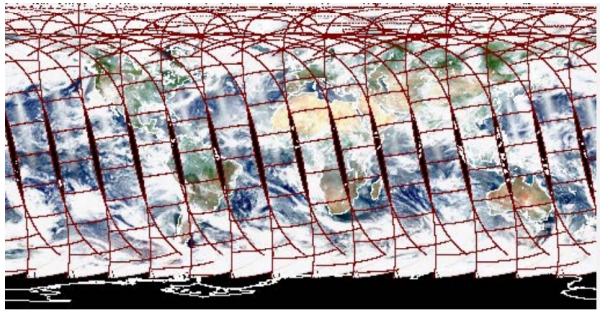
# NASA GMAO global meteorology and chemistry products

## GEOS



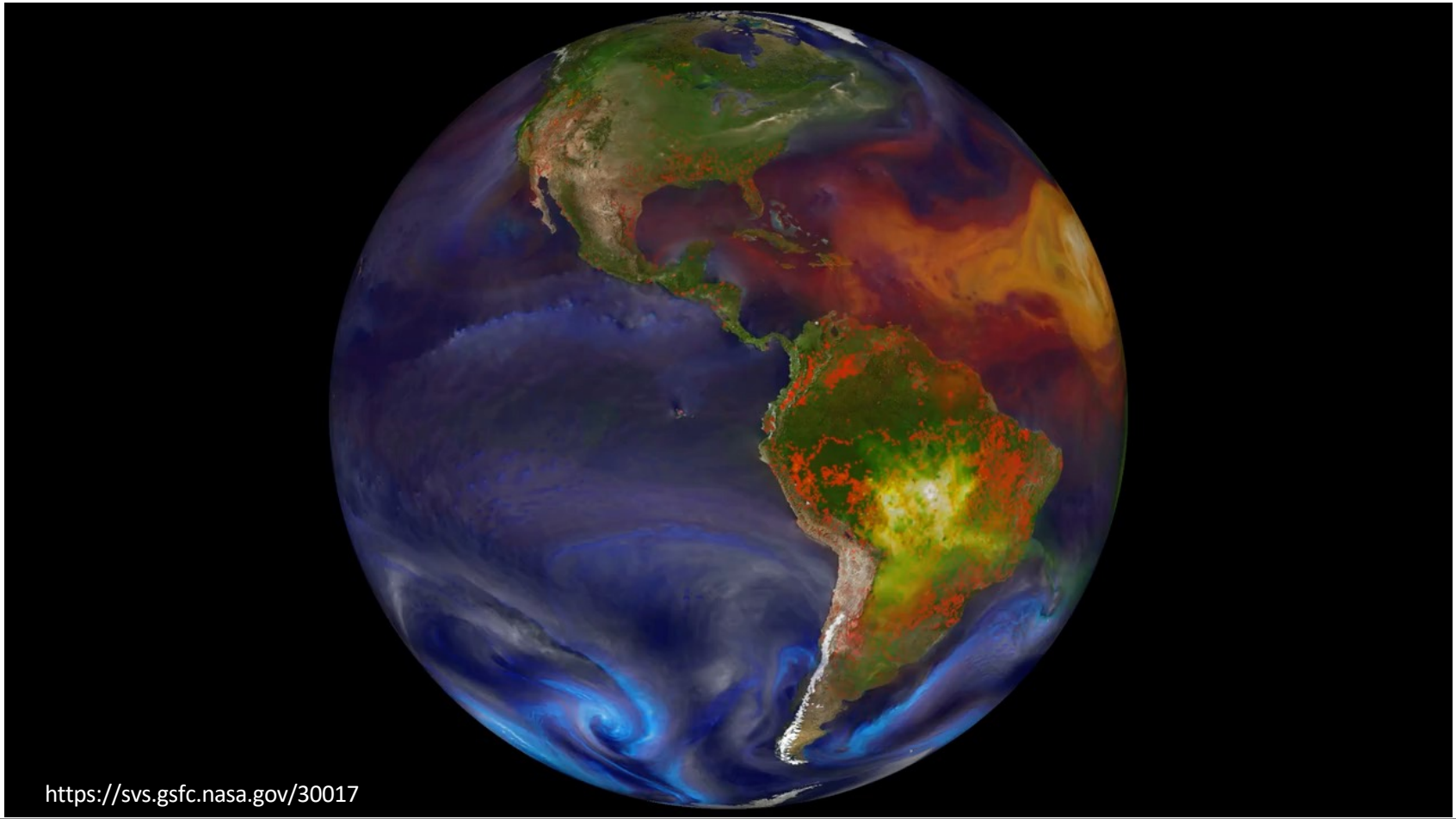



www.nasa.gov



https://modis.gsfc.nasa.gov/

# GEOS current capabilities



# NASA GMAO global meteorology and chemistry products

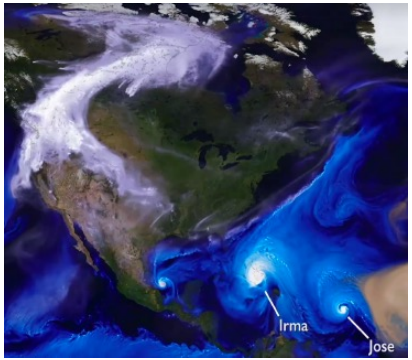
GEOS

Forecasting

Reanalysis

GEOS FP

MERRA-2



# GEOS aerosol data assimilation system

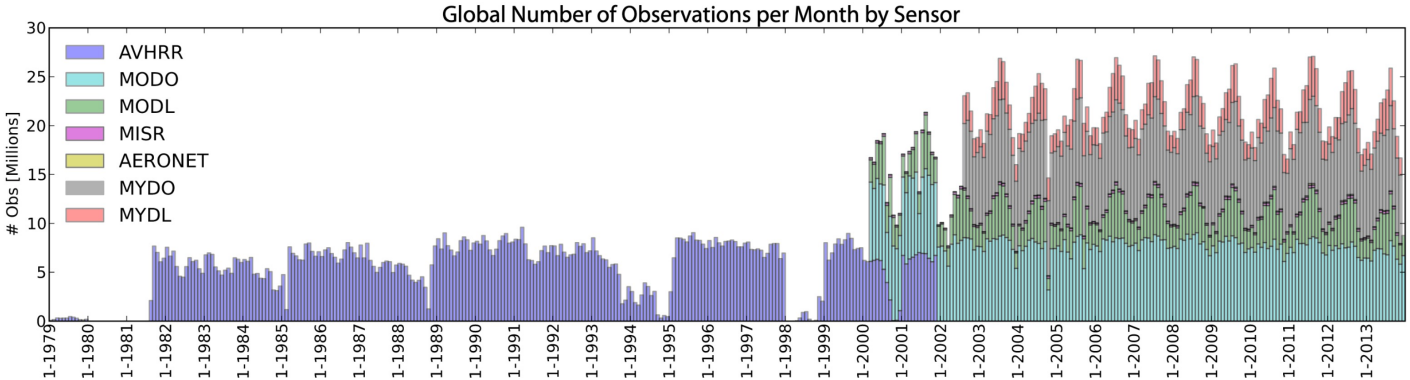
GEOS AGCM + GOCART aerosol module + DA (Meteorology, aerosol, ozone) → GEOS FP, MERRA-2, GEOS FP-IT, G5NR, …

<u>Emissions</u>
Biomass Burning: HFED, QFED
Anthropogenic: Edgar & AeroCom Phase II

<u>Aerosol Observing system</u>
Bias-corrected AOD (550 nm)

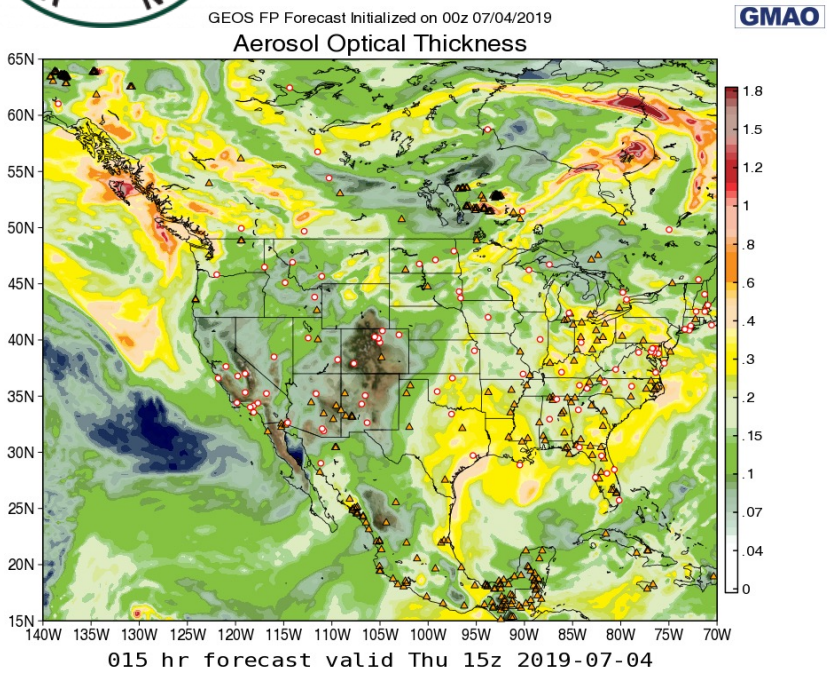
<u>Particulate matter (PM):</u>

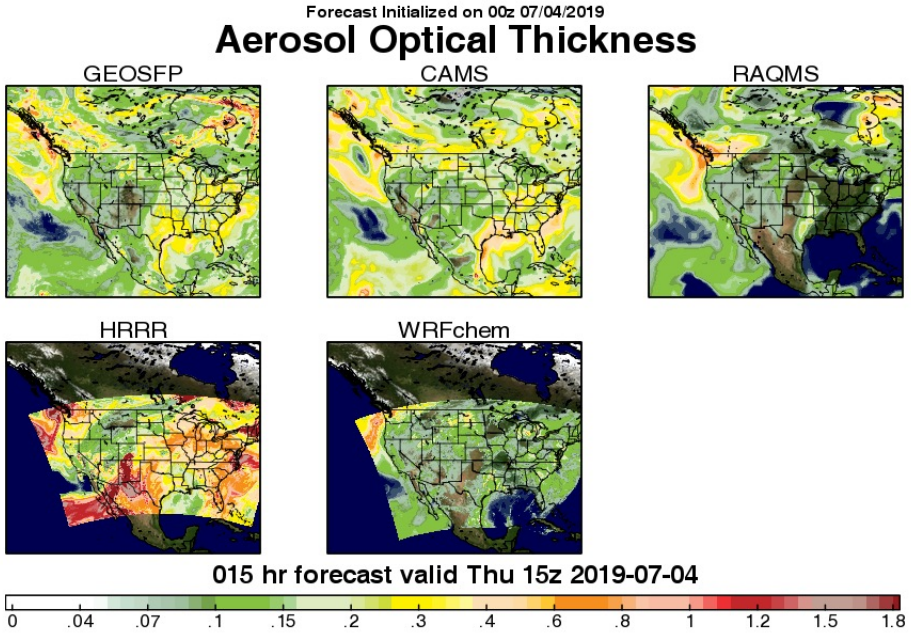
- Organic Carbon
- Black Carbon
- Sea salt
- Sulfate
- Dust
- Nitrate (GEOS FP)




Randles et al., 2016; NASA/TM–2016-104606/Vol. 45
Randles et al., 2017; DOI: 10.1175/JCLI-D-16-0609.1

# GMAO Field Campaign Support

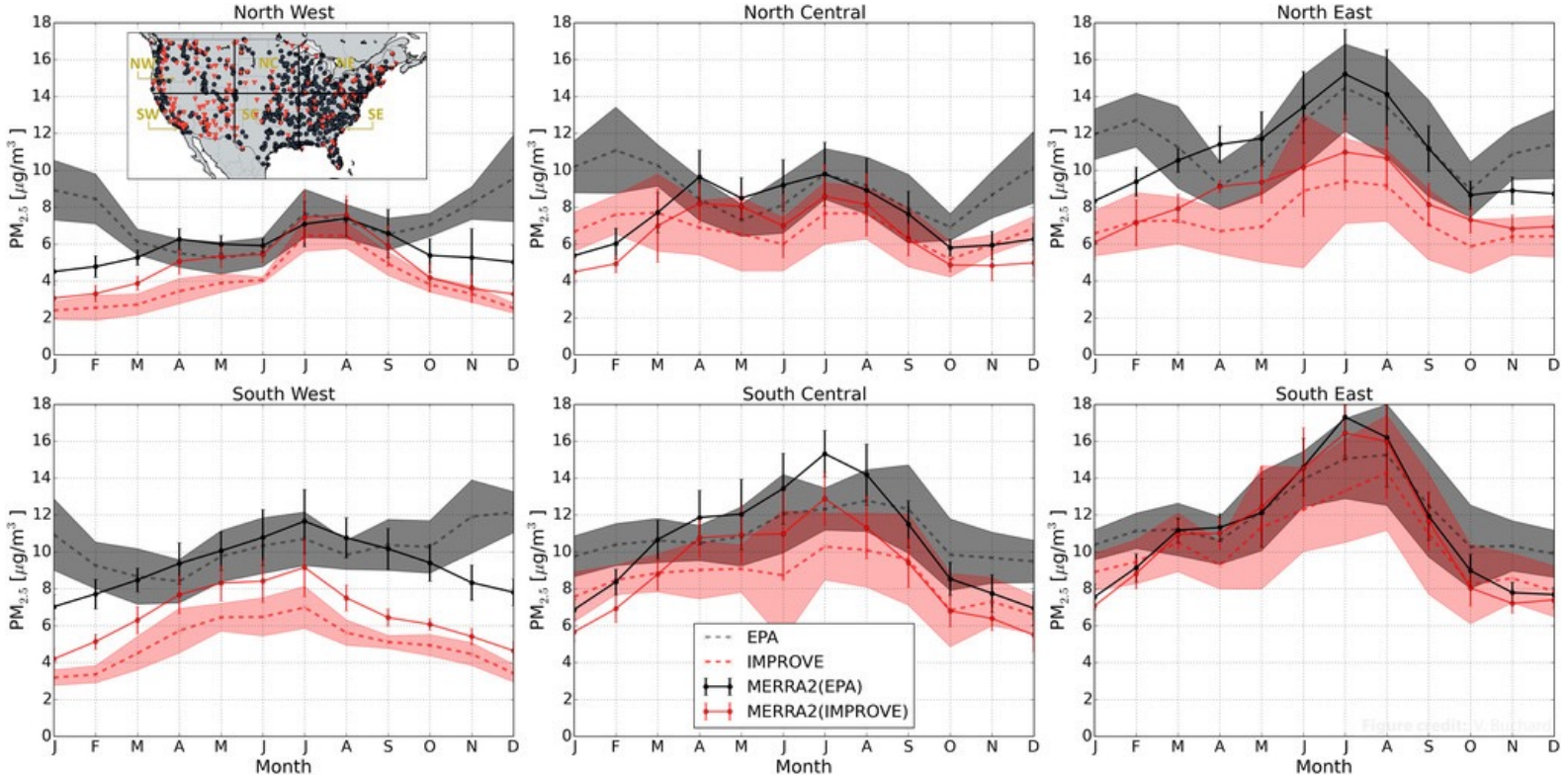



https://fluid.nccs.nasa.gov/missions/

# How best to evaluate the analyzed $PM_{2.5}$?

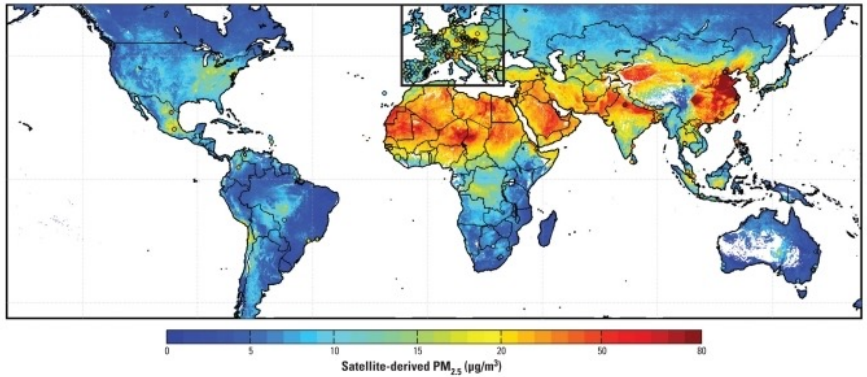
Available ground-based networks of $PM_{2.5}$



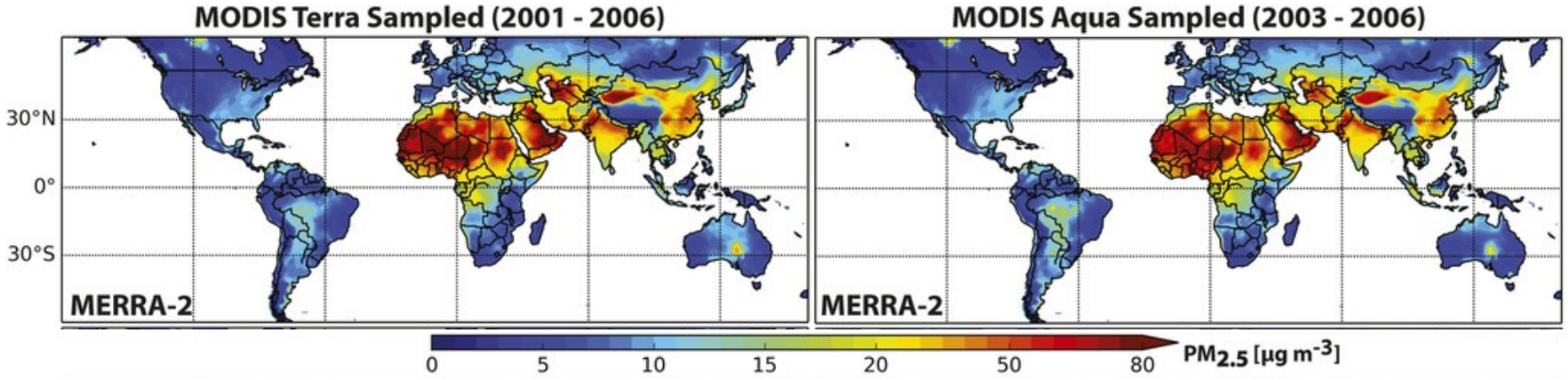

Buchard et al., 2017; DOI: 10.1175/JCLI-D-16-0613.1

# How best to evaluate the analyzed $PM_{2.5}$?

Satellite-based AOD estimate $PM_{2.5}$




van Donkelaar et al., 2010;
DOI: 10.1289/ehp.0901623




Buchard et al., 2017; DOI: 10.1175/JCLI-D-16-0613.1

# GEOS FP and MERRA-2 $PM_{2.5}$ available online

**FLUID is a mobile-friendly website**

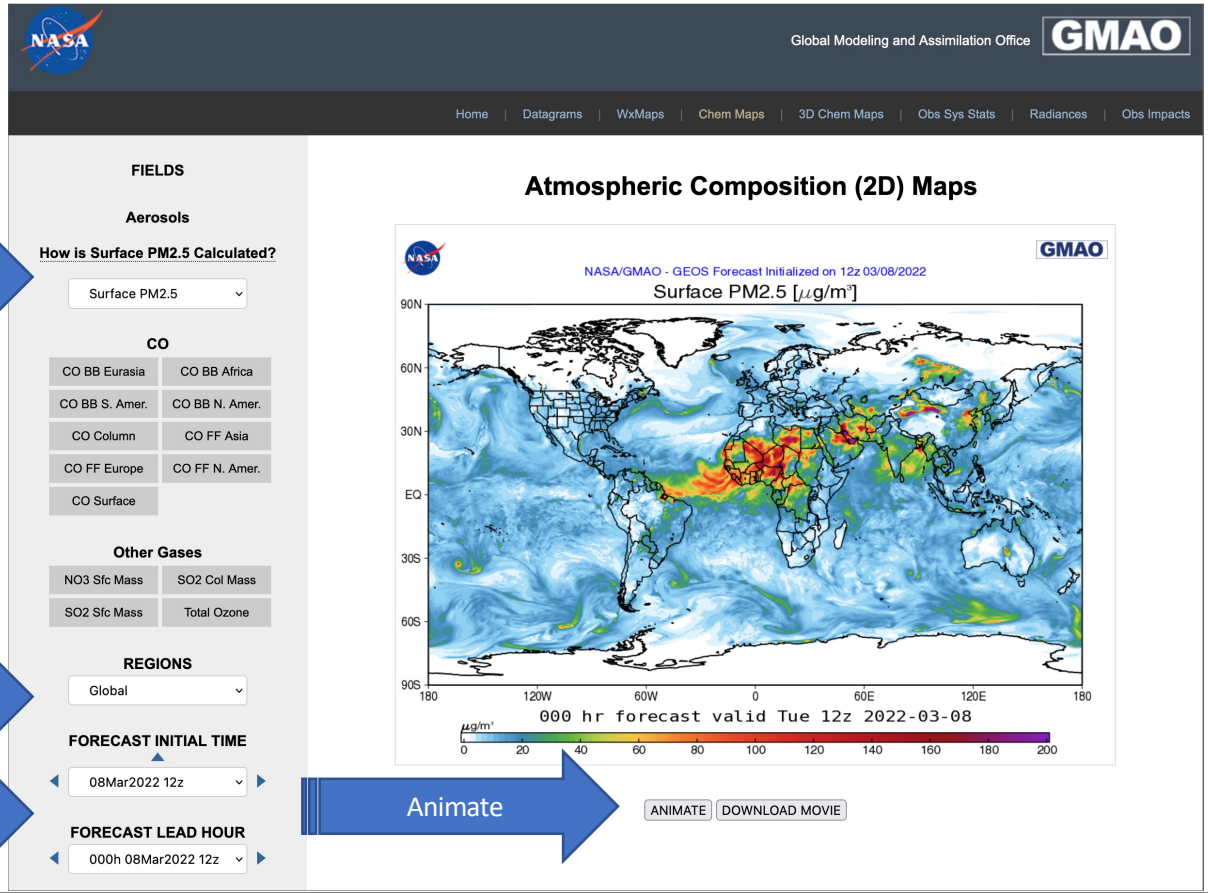
https://fluid.nccs.nasa.gov/wxmaps/chem2d

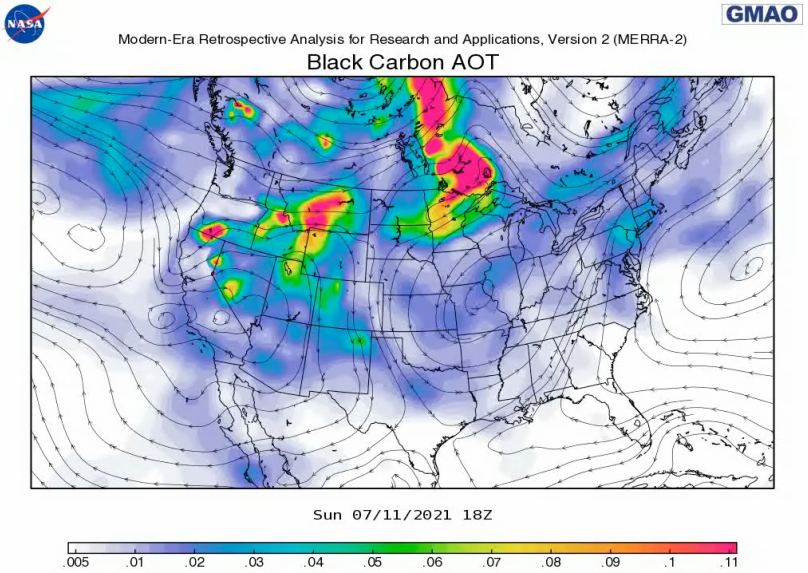
Select Surface $PM_{2.5}$

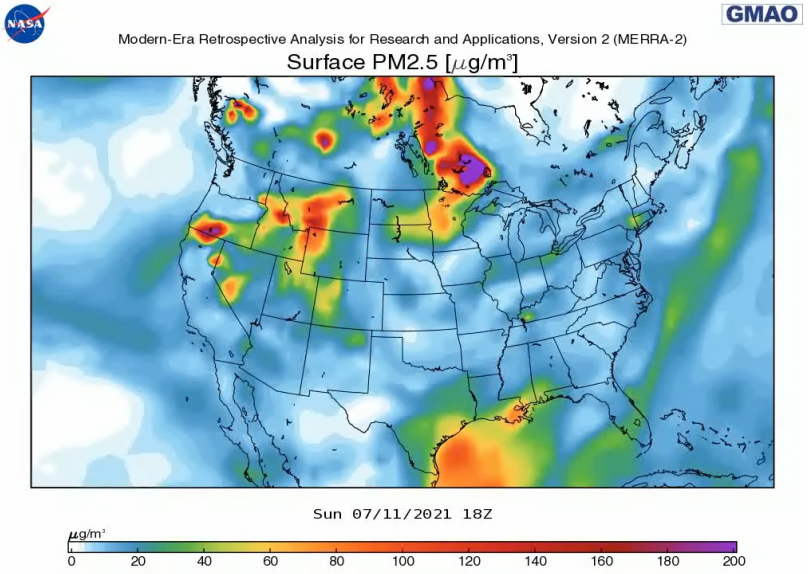
Select the region

Select Forecast

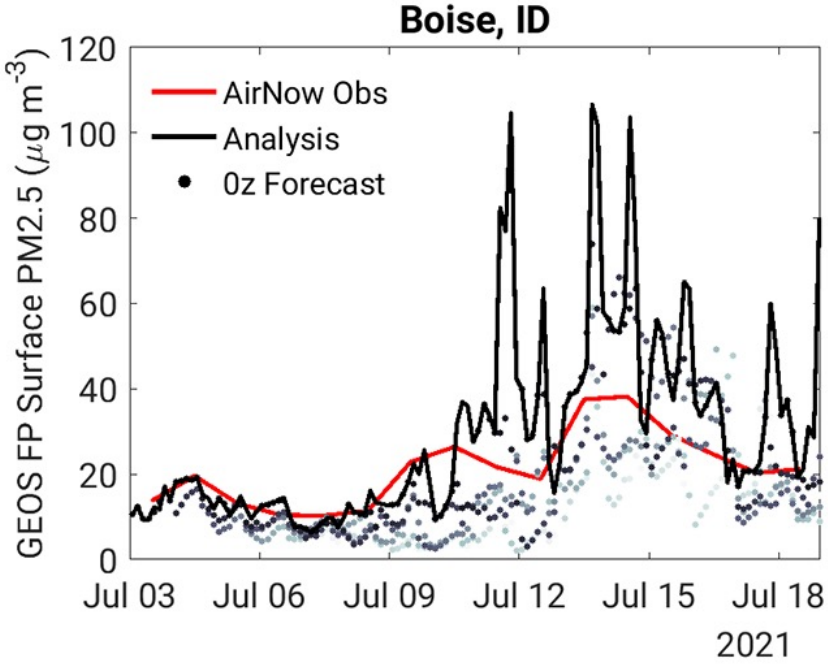
Animate






# Wildfires are major source of $PM_{2.5}$ in North America




https://gmao.gsfc.nasa.gov/research/science_snapshots/2021/na_biomass_burning_2021.php

# Dive into the GEOS Aerosol analyses

Global Modeling and Assimilation Office GMAO

Home | WxMaps | Chem Maps | Climatology & Anomalies | Climate Statistics

**FIELDS**

**AOT**

| | |
|---|---|
| Black Carbon | Dust |
| Fine | Organic Carbon |
| Sea Salt | Sulfate |
| Total | |

**Surface**

How is Surface PM2.5 Calculated?

| | |
|---|---|
| Surface PM25 | Black Carbon |
| Dust | Organic Carbon |
| Sulfur Dioxide | Sulfate |
| Sea Salt | |

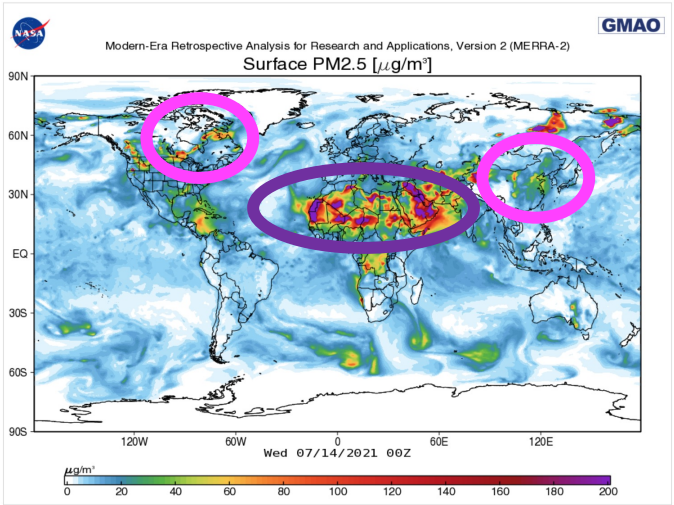
**Total Column**

Jul 2021

| Su | Mo | Tu | We | Th | Fr | Sa |
|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

2021-Jul-14

## Atmospheric Composition (2D) Maps

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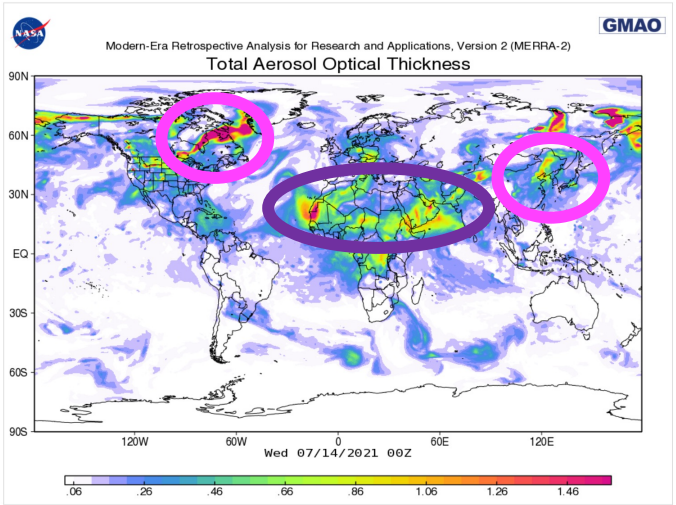


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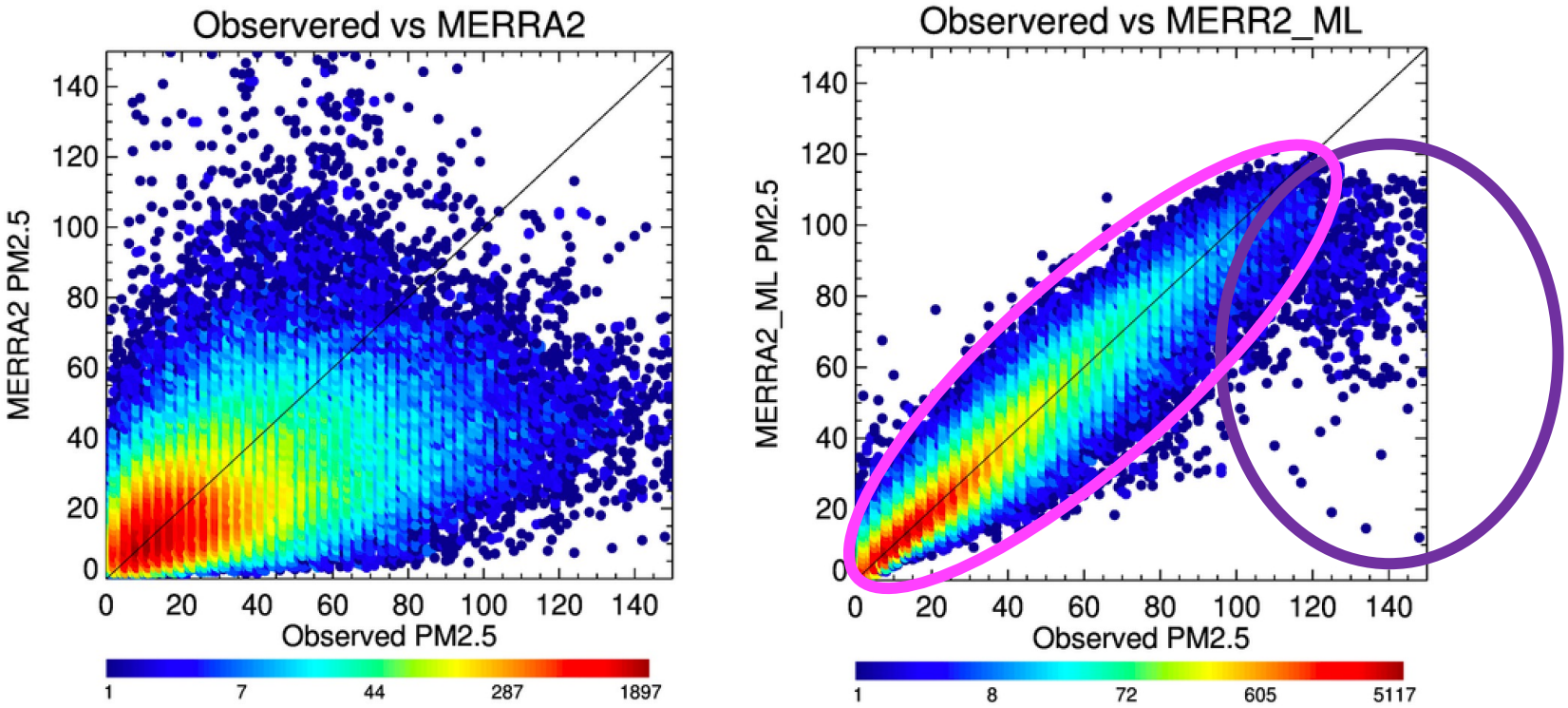
k.e.knowland@nasa.gov

# Machine Learning algorithms can help improve on biases in model $PM_{2.5}$ estimates




Gupta et al., 2021; DOI: 10.4209/aaqr.210105

# Summary

- GEOS Aerosol Data Assimilation System assimilates 2D column integrated AOD at 1 wavelength (550 nm)
- Surface $PM_{2.5}$ can be calculated from the speciated aerosol concentrations from the model's lowest layer
- Surface $PM_{2.5}$ maps are now available on FLUID for GEOS FP and MERRA-2

References
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